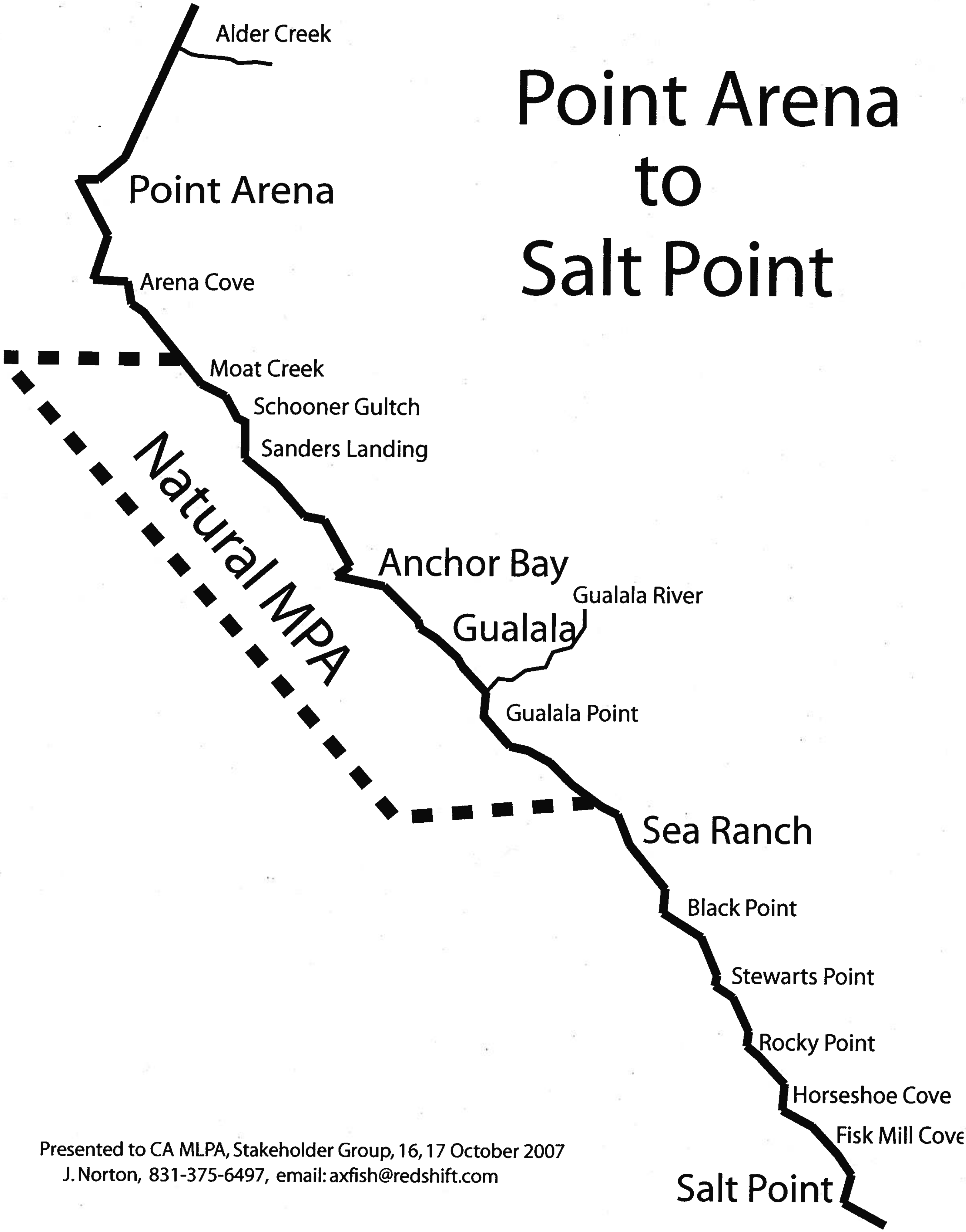
Point Arena to Salt Point



Presented to CA MLPA, Stakeholder Group, 16, 17 October 2007
J. Norton, 831-375-6497, email: axfish@redshift.com

Because of the ***latitude*** and ***angle*** of this area of coast (between Point Arena and Stewarts Point) and its ***position*** on the eastern side of the subtropical high atmospheric pressures system, this is one of the consistently ***windiest stretches of coastline*** on the west coast of North America.

This is a Natural MPA

Because of the persistent high winds

there are persistent high seas that

limit all recreational and most

commercial extractive activities

(fishing, diving, spearfishing)

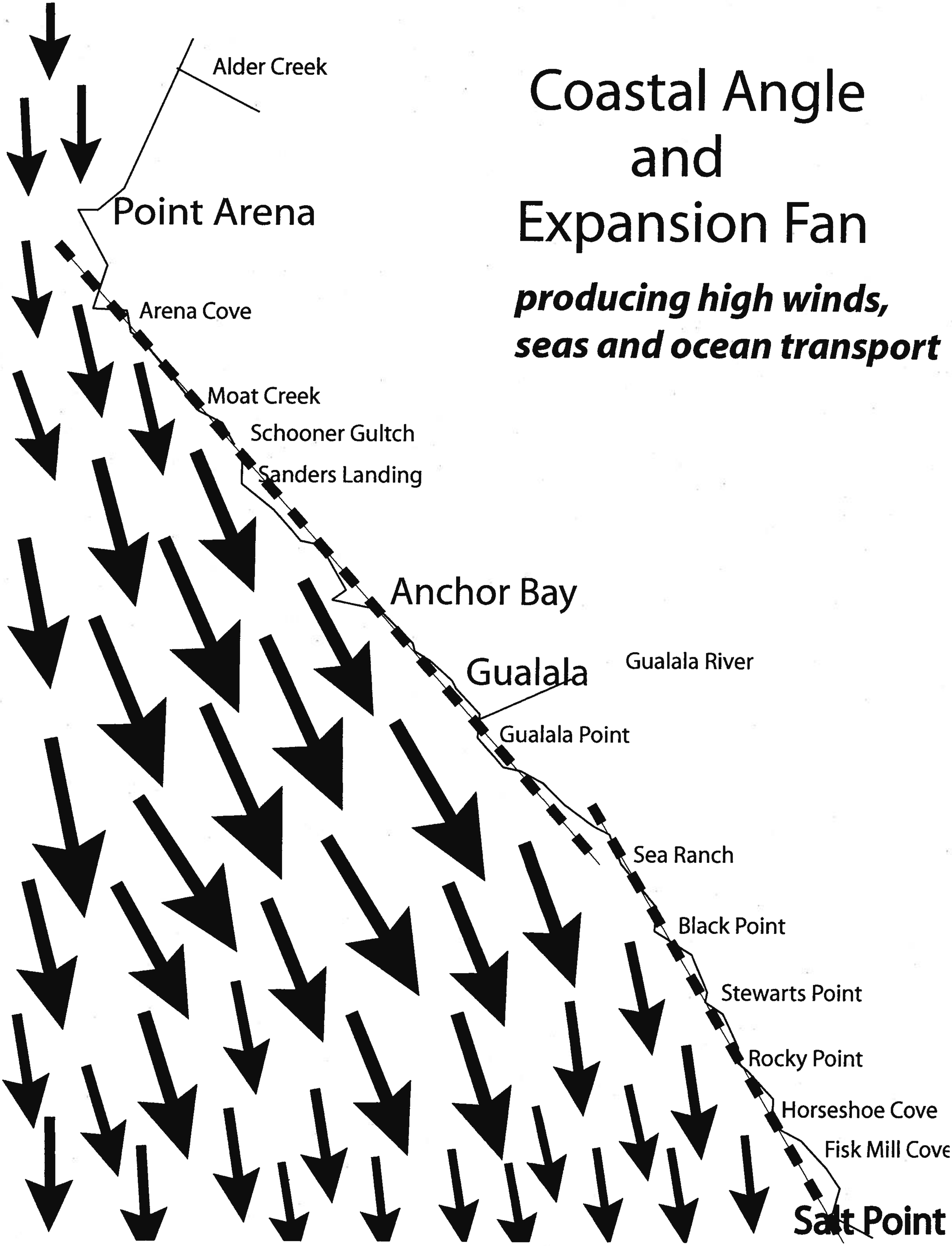
to a small fraction of the days that

are suitable and safe on other parts

of the coast ***(1/4 to 1/3)***.

Coastal Angle and Expansion Fan

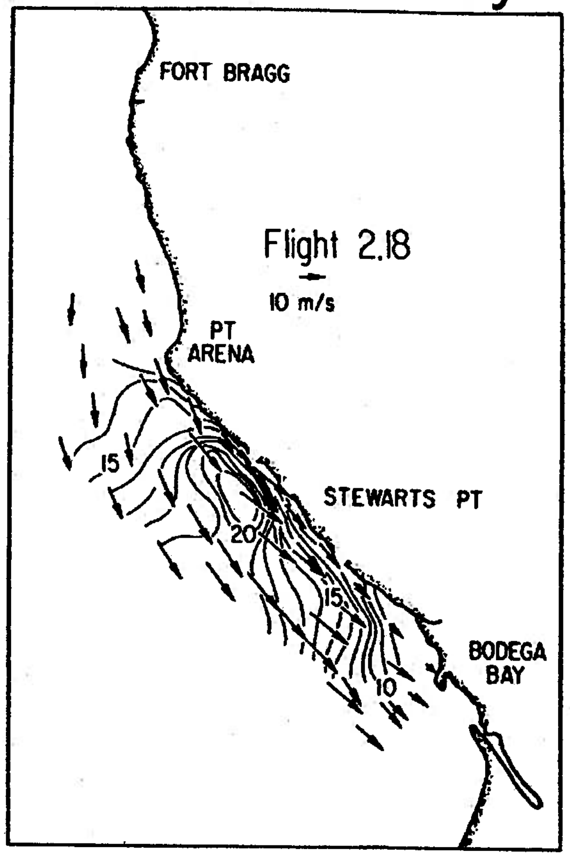
producing high winds, seas and ocean transport



Suggestion:

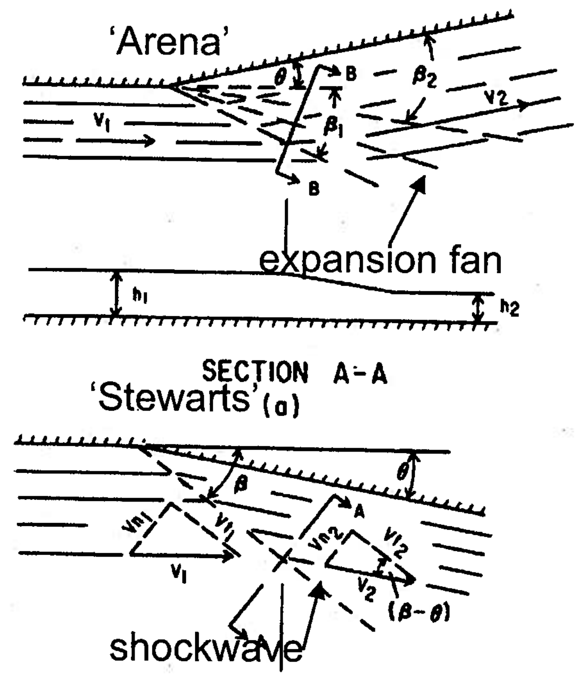
Leverage the advantages of the Natural MPA by putting ***smaller MPAs*** on each end of it, then the entire area becomes as good as a large MPA. *There is also accepted biological evidence that **larval retention in this area is not as good** as in adjacent areas of the coast.*

Dynamics of the MBL off California



MBL winds respond to turns in the coastline at Point Arena and Stewarts Point. At Pt. Arena the turn opens more area to the flow, while that at Stewarts Pt. closes it.

Arrows are wind vectors, contours are of wind speed (m/s).



Winant et al. treated the MBL flow like supersonic gas flow. The opening at Pt. Arena operates like an expansion fan accelerating the flow and thinning the layer. The opposite turn at Stewarts Pt. creates an oblique shock wave or hydraulic jump that abruptly slows the flow and thickens the layer.

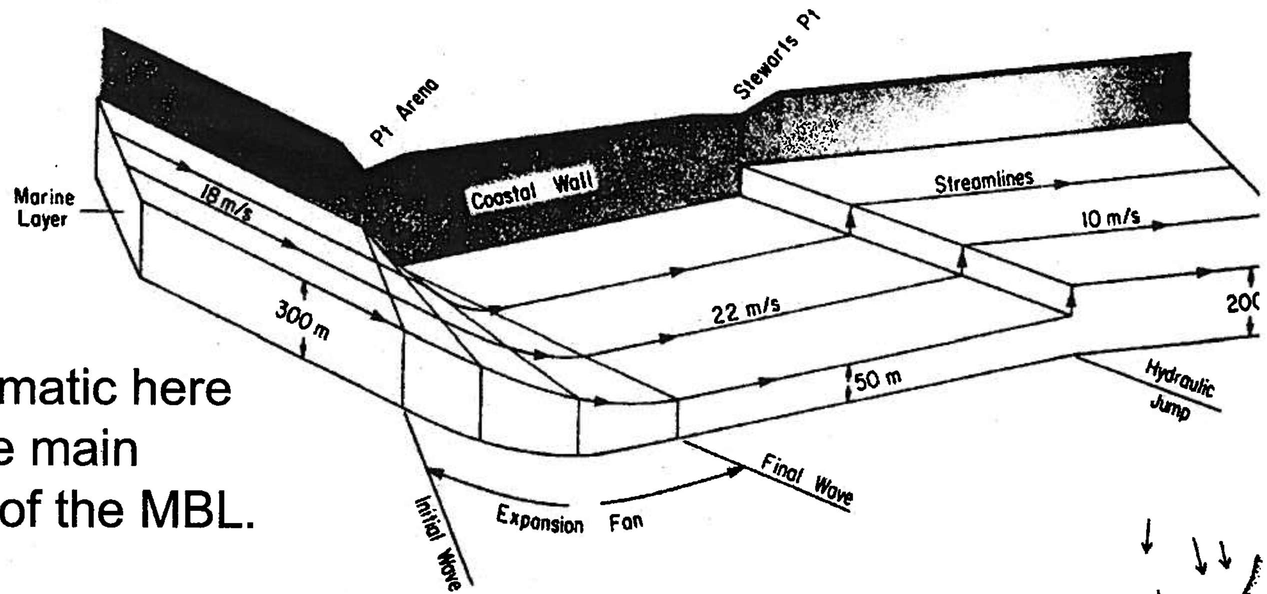
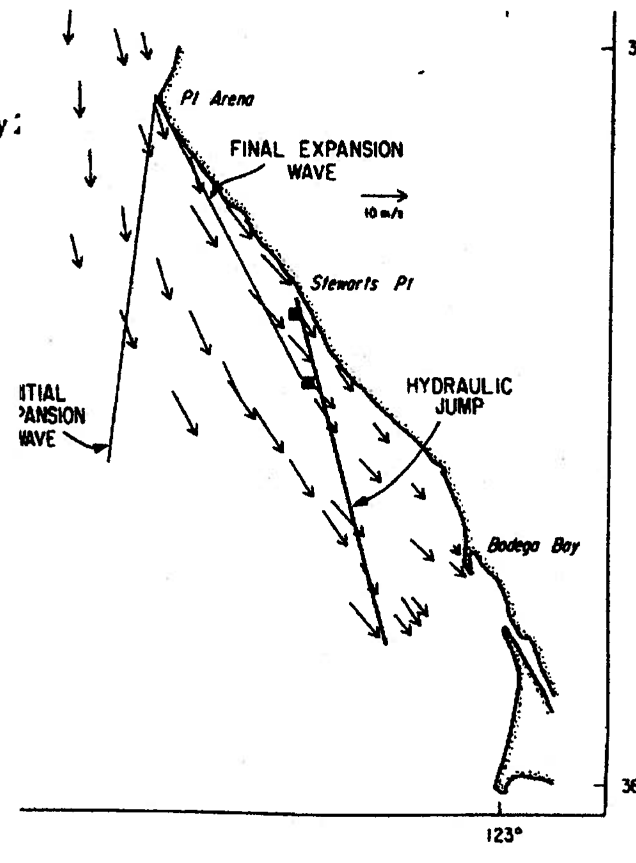


FIG. 8. A 3-D perspective, looking eastward, of the marine layer in the CODE area during survey 2

The schematic here shows the main features of the MBL.



The sketch on the right helps identify features of the process that are often missed .

Abstract View

Volume 45, Issue 23 (December 1988)

Journal of the Atmospheric Sciences
Article: pp. 3588–3605 | Abstract | PDF (1.38M)

The Marine Layer off Northern California: An Example of Supercritical Channel Flow

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ABSTRACT

During the spring and summer, northerly winds driven by the North Pacific high pressure system are prevalent over the Northern California continental shelf, only interrupted for periods of a few days, when weak or southerly winds occur. In the course of the Coastal Ocean Dynamics Experiment (CODE), fixed station and observations were made to describe the temporal and spatial structure of the lower atmosphere, and their relation to the strong upwelling of coastal waters in a region extending up to 40 km offshore and 100 km along the coast. These observations suggest that atmospheric conditions during the spring and summer usually fall into one of three categories: the surface wind can be everywhere weak (Pattern 1), it can blow at large speeds in a uniform pattern (Pattern 2), or finally the structure of the northerly surface wind can be complex, with large changes in the wind speed and corresponding changes in the surface pressure over short spatial scales (Pattern 3), The latter pattern, which occurs with generally northerly winds, is characterized by a strong low-level inversion and the spatial structure of the surface wind is correlated with the coastal topography. The inversion acts as a material interface, and the marine layer behaves as a supercritical channel flow, when the Froude number is greater than one: oblique expansion waves and hydraulic jumps, associated with changes in the orientation of the coastline, account for the observed spatial structure of the flow. Observations from mid-latitudes on the eastern side of other ocean basins suggest that similar supercritical conditions in the marine layer may prevail there also.

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Abstract View

Volume 25, Issue 7 (July 1995)

Journal of Physical Oceanography
Article: pp. 1651–1671 | Abstract | PDF (1.94M)

Effects of Wind Stress and Wind Stress Curl Variability on Coastal Upwelling

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ABSTRACT

Aircraft measurements during the winter 1989 Shelf Mixed Layer Experiment (SMILE) and summer 1982 Coastal Ocean Dynamics Experiment (CODE) were used to characterize the spatial variation of the low-level wind and wind stress over the northern California shelf. The curl of the wind stress was calculated from directly measured turbulent stress components. The accuracy of the computed curl was estimated to be adequate to map the spatial structure. Wintertime measurements showed a concentration of large positive curl [over 1 Pa (100 km)$^{-1}$] west of Point Arena, regardless of wind direction, due to the effects of the coastal topography on the wind fields. Results from summertime measurements showed a similar local maximum of positive curl west of Point Arena. Larger curl values [over 3.5 Pa (100 km)$^{-1}$], however, were observed across a hydraulic jump propagating from Stewarts Point for highly supercritical marine boundary-layer flow.

A two-layer, vertically integrated numerical model of coastal upwelling was used to assess the relative importance of the stress curl to the stress-driven transport. The nonzero stress curl altered the thickness of the upper layer considerably after a day of integration, expanding the horizontal extent of upwelling offshore. The greatest effects were around areas of high positive curl, increasing coastal upwelling for downcoast winds and decreasing downwelling for upcoast winds. The effect of the stress curl, however, was attenuated near the coast as compared to the maximum possible deep water values. The validity of the numerical model was verified by comparison with an analytical solution of a simplified set of one-dimensional, frictionless equations of motion.

Manuscript received December 2, 1993, in final form October 10, 1994

DOI: 10.1175/1520-0485(1995)025<1651:EOWSAW>2.0.CO;2

Full Text View

Volume 56, Issue 16 (August 1999)

Journal of the Atmospheric Sciences
Article: pp. 2761–2779 | Abstract | PDF (417K)

Transcritical Flows in the Coastal Marine Atmospheric Boundary Layer

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ABSTRACT

Numerical solutions of shallow water flow in a variable-width channel are computed to model the summertime marine atmospheric boundary layer off the U.S. west coast. Using an idealization of the coastline in the vicinity of Point Arena, California, as an example, several steady-state base flows are presented that are hydraulically transcritical. These flows are strongly nonlinear, weakly rotational, and are forced by constant pressure gradients and damped by nonlinear bottom drag at the sea surface. The transcritical base flows are supercritical in the vicinity of bends in the coastline but are subcritical to the north (upstream) and to the south (downstream) where the coastline is straight. Within the supercritical region, orographic bends in the coastline produce expansion fans and compression jumps, the same structures found in globally supercritical flows. When the imposed pressure-gradient forcing is increased, the resulting base flow has a supercritical-to-subcritical transitional jump that is weaker and located farther downstream, increasing the extent of the supercritical region. Perturbations are applied to the transcritical base flows in the south to study the interaction of coastal-trapped disturbances with the base flows. The disturbances propagate northward in the subcritical region of the base flow but can be halted after they reach the supercritical region. Very strong nonlinear disturbances can overcome the supercriticality of the base flow and propagate all the way up the coast but are severely attenuated in the process. The interaction of strong coastal-trapped disturbances with the transcritical base flows is accompanied by an eddy-generation process that resembles satellite images of stratus observed during the May 1982 coastal-trapped event off California.

Table of Contents:

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1. Introduction

During the Coastal Ocean Dynamics Experiment (CODE) off the U.S. west coast in 1981 and 1982, alongshore aircraft

Wing, S. R., J. L. Largier and L. W. Botsford. 1998.

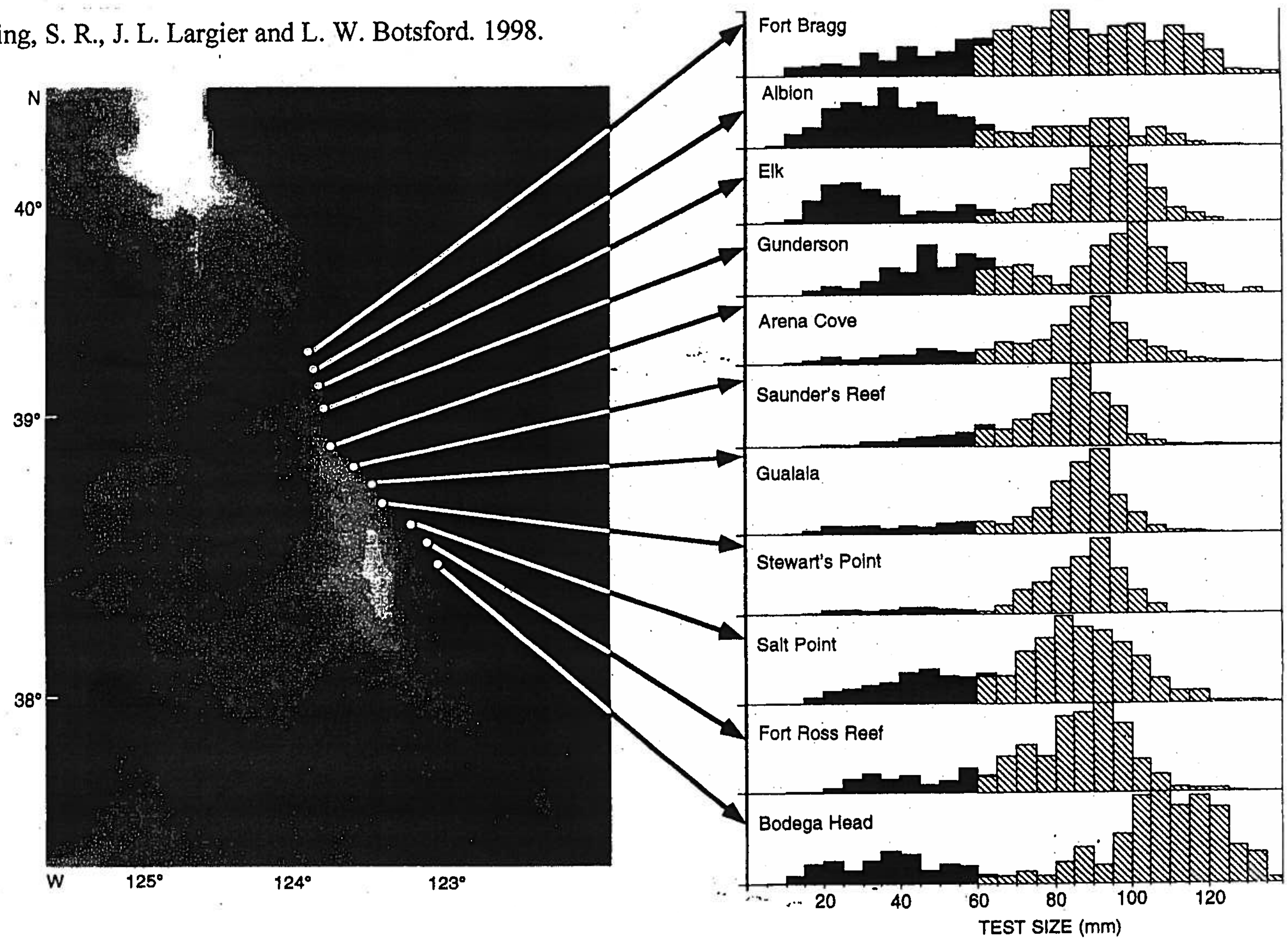

Fig. 4: Map of size distributions of Red Sea urchins *S. franciscanus* relative to two relaxation features in northern California. Size distributions show frequency of different test sizes in each of 11 subpopulations (each n >600). Dark bars indicate individuals <60 mm. AVHRR image shows sea surface temperature during typical relaxation conditions, ranging from 9°C (lightest grey) to 16°C (darkest grey)

Wing, S. R., J. L. Largier and L. W. Botsford. 1998. Coastal retention and longshore displacement of meroplankton near capes in easter boundary currents: Examples fro the California Current, In Benguela Dynamics. S. Afr. J. mar. Sci. 19: 119 – 127.

An equilibrium model for predicting the efficacy of marine protected areas in coastal environments

Carl J. Walters, Ray Hilborn, and Richard Parrish

Abstract: Quantitative models of marine protected area (MPA) proposals can be used to compare outcomes given current biological knowledge. We used a model of a linear coastline, with 200 discrete cells each spanning 1.6 km of coast. This model is used to evaluate alternative proposals for marine protected area networks, predicting equilibrium changes in abundances and harvests while accounting for dispersal of larvae and older fish, changes in fecundity with reduced mortality in reserves, impacts of displaced fishing effort on abundances outside reserves, and compensatory (stock–recruitment) changes in postsettlement juvenile survival. The model demonstrates that modest dispersal rates of older fish can substantially reduce abundance within protected areas compared with predictions from models that ignore such dispersal. The strength of compensatory improvements in postsettlement juvenile survival is the most critical factor in determining whether a reserve network can rescue populations from the impacts of severe overharvesting. We use the model to compare specific alternative proposals for protected area networks along the California coast, as mandated through California's Marine Life Protection Act, and show that achieving the goals of the Act depends primarily on the fisheries management regulations outside of protected areas and that the size and configuration of MPAs has little impact.

Résumé : Des modèles quantitatifs des propositions de zones de protection marines (MPA) peuvent servir à comparer les résultats escomptés, compte tenu des connaissances biologiques actuelles. Nous utilisons un modèle comprenant une côte linéaire avec 200 cellules distinctes couvrant chacune 1,6 km de côte. Le modèle sert à évaluer des propositions de rechange pour un réseau de zones de protection marines en prédisant les changements des abondances et des récoltes à l'équilibre, tout en tenant compte de la dispersion des larves et des poissons plus âgés, du changement de fécondité relié à la diminution de la mortalité dans les réserves, des impacts sur l'abondance des efforts de pêche relocalisés hors des réserves et les changements compensatoires (stock–recrutement) de la survie des jeunes après leur établissement dans le milieu. Le modèle démontre que les taux de déplacement modestes des poissons plus âgés peuvent réduire considérablement les abondances dans les zones protégées, en contraste des prédictions des modèles qui ignorent ces déplacements. L'importance de l'amélioration compensatoire de la survie des jeunes après leur établissement est le facteur le plus critique pour déterminer si un réseau de réserves peut sauver une population des effets d'une récolte excessive. Nous utilisons le modèle pour comparer des propositions spécifiques de rechange de réseaux de zones de protection le long de la côte de la Californie, tel que requis par la loi californienne de protection de la vie marine (California Marine Life Protection Act), et nous démontrons que l'atteinte des objectifs de la loi dépend principalement des règlements de gestion des pêches à l'extérieur des zones de protection et que la taille et la configuration des MPA ont peu d'effet.

[Traduit par la Rédaction]

Introduction

A number of relatively simple, one-dimensional models have been proposed for evaluating population impacts of networks of marine protected areas (MPAs) distributed along coastal shorelines and extending offshore far enough to protect animals that undergo ontogenetic offshore movements (e.g., Botsford et al. 2004; Gaylord et al. 2005; Kaplan and Botsford 2005). The basic idea in these models has been to divide the shoreline into a large number of small (e.g., 1 km or 1 nautical mile (= 1.852 km)) spatial slices or cells, then predict changes in abundance within each of the cells. Typically, these models have accounted for linkage among cells through larval dispersal and for compensatory changes in juvenile survival rates after larval settlement. However, they have not accounted for dispersal of older animals or changes in fishing impacts in remaining open areas because of displacement of fishing effort out of reserve areas and (or) fisheries regulations aimed at reducing overall fishing mortality rates whether or not reserves are present. Models that do account for movement of older animals and spatial redistribution of fishing effort (Walters et al. 1999; Walters

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Global Climate Change and Intensification of Coastal Ocean Upwelling

ANDREW BAKUN

A mechanism exists whereby global greenhouse warming could, by intensifying the alongshore wind stress on the ocean surface, lead to acceleration of coastal upwelling. Evidence from several different regions suggests that the major coastal upwelling systems of the world have been growing in upwelling intensity as greenhouse gases have accumulated in the earth's atmosphere. Thus the cool foggy summer conditions that typify the coastlands of northern California and other similar upwelling regions might, under global warming, become even more pronounced. Effects of enhanced upwelling on the marine ecosystem are uncertain but potentially dramatic.

THE COASTAL OCEAN OFF THE WESTern United States is a classic wind-driven coastal upwelling system (*1*, *2*). During the warmer seasons of the year, strong northerly and northwesterly winds induce offshore transport of surface waters. Upwelling of cool, nutrient-enriched water from depth (Fig. 1) balances the resulting loss of surface water near the coast and infuses essential plant nutrients to the surface layers of the ocean. Rich phytoplankton growth supports an abundant trophic pyramid, including valuable fishery resources and important seabird and marine mammal populations (*3*). Cooling and stabilization of the onshore air flow by contact with the upwelled surface waters leads to the cool summer climate of the adjacent coastlands (*4*). Similar upwelling systems occur in the other major subtropical eastern ocean boundary regions; examples are the Canary current system off the Iberian Peninsula and northwestern Africa, the Benguela current system off southwestern Africa, and the Peru current system off western South America. Upwelling in all of these regions tends to be highly seasonal in temperate latitudes, where it peaks in the spring-summer, but tends toward year-round continuity in the more tropical portions (*1*).

The vigorous alongshore wind that drives coastal upwelling in these systems is maintained in part by a strong atmospheric pressure gradient between a thermal low-pressure cell that develops over the heated land mass and the higher barometric pressure over the cooler ocean (*5*). Because of the large-scale atmospheric subsidence occurring in the eastern limbs of the subtropical gyres, and also because of the stabilized, dehumidified onshore air flow, the areas of these coastlands inland of the direct influence of coastal stratus and fog are characterized during the upwelling seasons by dry Mediterranean-type (or desert) climates and clear atmospheric conditions (*4*). The clear conditions lead to strong daytime heating by short-wave solar radiation, particularly in interior valleys such as the Central Valley of California, and rapid nighttime, long-wave radiative cooling.

Recent decades have seen a substantial build-up of CO_2 and other greenhouse gases in the earth's atmosphere (*6*). Resulting inhibition of nighttime cooling and enhancement of daytime heating should lead to intensification of the continental thermal lows adjacent to upwelling regions. This intensification would be reflected in increased onshore-offshore atmospheric pressure gradients, intensified alongshore winds, and accelerated coastal upwelling circulations (Fig. 1). As a positive feedback, the cooling of the ocean surface that results might locally intensify the low-altitude barometric highs at the oceanic sides of the onshore-offshore pressure gradients.

No routine observations of actual rate of upwelling are available. Accordingly, a coastal upwelling index based on an estimate

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Jan 1990

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Meroplanktonic distribution and circulation in a coastal retention zone of the northern California upwelling system

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Abstract

Previous studies have shown that settlement of several crab species along the coast north of Point Reyes (38°00′N, 123°00′W) occurs primarily during relaxation from upwelling, when warm water flows poleward from the Gulf of the Farallones. During 1994 and 1995 we sampled planktonic larval distributions and hydrography both south and north of Point Reyes during upwelling to test whether high concentrations of crab and rockfish larvae were concentrated in the source of the relaxation flow to the south of Point Reyes. An upwelling plume off Point Reyes and an "upwelling shadow," indicated by warmer, less saline water in the northern Gulf, were evident in both years, as were frontal regions that marked the boundaries between water types of three different types: (1) newly upwelled, (2) oceanic, and (3) San Francisco Bay outflow. In addition, there was a fourth type, termed Gulf water, that was a mixture of these three types. Concentrations of larvae of cancrid, pinnotherid, and "coastal" crabs and rockfishes were high south of Point Reyes but were low or absent in the newly upwelled water north of the point. Within the upwelling shadow, these meroplankton taxa were associated with different water masses. Several intertidal crab species and early-stage cancrid crabs were concentrated in San Francisco Bay outflow water, and coastal Gulf water late-stage cancrid crabs, early- and late-stage pinnotherid crabs, and rockfishes were concentrated at the frontal region between newly upwelled and Gulf water. Of the taxa examined, only rockfishes were found offshore in oceanic water. The high concentrations of meroplankton observed suggest that the Gulf of the Farallones is an important retention area for larvae that settle into coastal populations in the Gulf and to the north via poleward transport during upwelling relaxation.

In the California Current System (CCS), the presence from March through July of offshore transport and an equatorward coastal jet due to upwelling (e.g., Huyer 1983), offshore jets near promontories (e.g., Davis 1985), and eddies and meanders offshore from the U.S.–Canada border to Mexico (Strub et al. 1991) has led researchers to question how larvae of meroplanktonic coastal species avoid being transported offshore or equatorward, beyond areas where they can successfully settle and develop to reproduce (e.g., Parrish et al. 1981; Simpson 1987; Roughgarden et al. 1991; McConnaughey et al. 1994). This question indicates a general issue in marine population ecology related to this region, that being the manner in which physical/biological interactions provide the larval transport and survival needed for successful closure of the life cycles of fishes and invertebrates (Simpson 1987; Sinclair 1988; Frank 1992).

Stratification of mero- and holoplanktonic larvae along the shore suggests the existence of physical mechanisms (e.g., fronts) that might serve to limit cross-shelf loss of larvae off the coast of Oregon (Richardson and Pearcy 1977; Peterson et al. 1979; Richardson et al. 1980; Wroblewski 1980). In central California, Roughgarden et al. (1991) proposed that concentration of barnacle larvae in an offshore upwelling front during active upwelling and subsequent onshore transport during upwelling relaxation explained the occurrence of settlement pulses during relaxation (e.g., Farrell et al. 1991). There is evidence that some types of larvae can be washed far offshore by the eddy structures and filaments in the CCS (Haury et al. 1986; Kosro and Huyer 1986; Washburn et al.

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